SECTION 8

Service and repair

8.1 Introduction

8.1.1 How to use this section

This section describes how to repair the major ventilator subassemblies and their components. These repair procedures include removal, installation, and adjustment, as applicable. This section does not provide complete breakdowns of all assemblies and complete disassembly information. Repair procedures are provided mostly for major components. For a complete illustrated parts breakdown (IPB), refer to Section 9. Do not rely exclusively on Section 9 for removal and installation of parts.

8.1.2 General repair safety

- When servicing the ventilator, be sure to familiarize yourself with and adhere to all posted and stated safety warning and caution labels on the ventilator and its components, and on any service equipment and materials used. Failure to adhere to such warnings and cautions at all times may result in injury or property damage.
- To prevent patient injury, do not use a ventilator if it requires repair.
- To prevent personal injury or death, do not attempt any ventilator service while a patient or other person is connected to the ventilator.
- Use personal protective equipment whenever exposure to toxic fumes, vapor, dust particles, blood pathogens, and other transmittable diseases and hazardous material can be expected. If in doubt, consult an environmental, health, and safety specialist or an industrial hygienist before servicing the ventilator.
- To prevent electrical shock hazard and possible personal injury, always disconnect electrical power sources before servicing the ventilator. This means disconnecting not only mains power but also battery power from the BBU PCB. If the ventilator must be serviced with the power on, be careful to avoid electrical shock. Avoid reaching into the ventilator. Follow accepted safety practices for electrical equipment when testing or making equipment adjustments or repairs.
- To prevent possible personal injury, always disconnect oxygen source from the ventilator before service.
- To prevent possible personal injury, never attempt to push or pull a ventilator installed on a cart while the brakes are set on the casters.
- To prevent possible personal injury and equipment damage, make sure the brakes on the casters are set to prevent inadvertent movement of the ventilator during service.
- To prevent injury, never attempt to lift the ventilator without assistance. When lifting the ventilator, lift from the base, use assistance, and take appropriate safety precautions.

- To prevent equipment damage, pull, rather than push, the ventilator over high thresholds when using the cart to transport the ventilator. Ensure that the flex arm is positioned at the front of the ventilator.

8.1.3 General repair guidelines

Follow these general guidelines when servicing the ventilator:

- Adhere to general repair safety instructions at all times.
- Always use metric tools to remove metric fasteners. Using nonmetric tools to remove metric fasteners can damage fasteners.
- Use Phillips screwdrivers only to remove Phillips-head screws. Use POZIDRIV screwdrivers only to remove POZIDRIV screws. Interchanging screwdrivers may cause damage to screw heads.
- To prevent damage to electrostatic discharge (ESD) sensitive components, always follow ESD guidelines when servicing the ventilator. Adhere to ESD control techniques when repairing ESD-sensitive components.
- Use only recommended tools, test equipment, and service materials when servicing the ventilator (Section 1).
- Take precautions to prevent dirt and other particles from entering the ventilator interior, particularly the piston/cylinder assembly.
- As you repair the ventilator, perform any applicable cleaning and inspection procedures listed below.
- Visually inspect any removed ventilator parts, including those removed to gain access to a suspected faulty part. Inspect the exposed area behind the removed parts as well. Clean removed parts to facilitate further inspection as necessary.
- Investigate and determine the cause of any detected abnormality. Repair the unit or contact your regional Nellcor Puritan Bennett Technical Support for help in diagnosing unresolved symptoms.
- Replace or repair all parts that are worn, missing, damaged, cracked, corroded, burnt, warped, bent, disfigured, or broken. Consult Section 9 for parts availability.
- The repair sections assume that the patient system, flex arm, oxygen, and humidifier are already removed from the ventilator.
- When installing a new oxygen regulator, oxygen solenoid, pressure solenoid PCB, flow sensor, or piston/cylinder assembly, always (1) input the calibration constants for the new assembly into NVRAM (Section 4), and (2) affix the small calibration constants label provided on top of the larger calibration constants label inside the lid.

8.1.4 Repair-related cleaning

If needed, follow these general guidelines when cleaning the ventilator during servicing. Procedures for periodic cleaning and sterilization of the ventilator and accessories are given in the *700 Series Ventilator System Operator's Manual*. Specific procedures for periodic cleaning and inspection done during the ventilator's performance verification are given in Section 5 of this manual.

- Clean ventilator exterior surfaces before disassembly. Use isopropyl alcohol, a bactericidal agent, or a mild detergent and warm water solution, and a clean, lint-free cotton rag. Allow cleaned ventilator parts and surfaces to air-dry. The use of solvents and harsh cleaning detergents is not recommended.
- Vacuum ventilator interior using ESD-safe equipment. Do not clean ventilator interior with high-pressure air.
- During disassembly, clean parts as necessary with isopropyl alcohol. Replace any parts that cannot be cleaned.

8.1.5 Electrical cables and pneumatic tubing

- To ensure proper reassembly, note or label wire or tube positions before disconnecting parts.
- When pulling silicone tubes off fittings, pull gently while turning to avoid shredding the tubing.
- Make sure all tubes and harnesses or cables are reinstalled using cable ties, as specified. Make sure wiring does not interfere with and cannot be damaged by hinged or moving ventilator parts. Make sure that the grounding harness is replaced to the oxygen regulator.

8.1.6 Adhesive use

- When installing a part to be attached with adhesive, first remove the adhesive residue using a suitable scraping tool that won't scratch the ventilator surface. Clean scraped surfaces thoroughly with isopropyl alcohol. Be sure the application area is free of dust and grease, then press on item, ensuring adhesive contact and bonding. Eliminate any trapped air bubbles.
- Be careful when using any cleaners and solvents, as these may cause personal injury or damage to ventilator surfaces. Use in a well ventilated area.
- Replace any damaged warning and caution labels using the removal and installation techniques described above.

Warning

The failure to replace damaged warning, caution, and identification labels may result in personal injury, equipment, or property damage.

8.1.7 Electrostatic discharge control

It is important to follow ESD control procedures whenever the ventilator is repaired.

8.1.7.1 General information

ESD can permanently damage ESD-sensitive microelectronic components or assemblies when they are handled and even when no direct contact is made with the component or assembly. ESD damage may not be immediately detectable; however, ESD damage will show up at a later time, either as a premature catastrophic failure of a component or assembly, or as an intermittent failure, which can be difficult and costly to locate.

The following static-shielding bags are available to store *700 Series Ventilator System* components:

Part number	Description
G-061534-00	Electrostatic-shielding bag, 66 x 46 cm (26 x 18 in.), for UI display PCB
G-061533-00	Electrostatic-shielding bag, 28 x 38 cm (11 x 15 in.), for controller PCB, BBU PCB, or pressure solenoid PCB
G-061532-00	Electrostatic-shielding bag, 13 x 20 cm (5 x 8 in.), for optoswitch

8.1.7.2 Procedures and precautions

Follow these procedures and precautions to prevent ESD damage to the ESD-sensitive microelectronic components and assemblies of the *700 Series* Ventilators.

- **Use a personnel grounding system.** Before opening the ventilator lid or removing its cabinet panels, ensure that a personnel grounding system such as Nellcor Puritan Bennett P/N G-061661-00 (wrist strap, static-dissipative mat, and ground cord) is worn correctly and is properly connected to a reliable ground.
- **Follow correct procedures for use of static-dissipative mat.** Place tools, test equipment and the ESD-sensitive device on the mat before starting repairs. Conduct all work from the mat. Never place nonconductive items (for example, foam cups) on the mat.
- **Handle ESD-sensitive components properly.** Do not handle ESD-sensitive component connection points, connector pins, leads, or terminals.
- **Keep nonconductive materials away from work area.** Static charges from nonconductive material (plastic containers, foam cups, synthetic clothing, cellophane tape, etc.) cannot be removed by grounding. These items must be kept away from the work area when handling ESD-sensitive devices.
- **Follow correct procedures for use of static-shielding bags.** Store and transport all ESD-sensitive devices in static-shielding bags at all times except when being worked on. Never place more than one ESD-sensitive device in a static-shielding bag. Never place static-generating nonconductive material inside a static-shielding bag with an ESD-sensitive device. Place any faulty ESD-sensitive device in a static-shielding bag immediately after removal to prevent additional damage. Close the bag to ensure that shield is effective.

8.1.8 Repainting and touch-up

Before repainting or touching up the ventilator, smooth out the area with a fine sandpaper, and make sure it is free from any grease, corrosion, or dust. Remove the part to be painted or mask off the surrounding area to prevent overspray or spills.

Use the following touch-up paints for the ventilator:

- Charcoal liquid lacquer (P/N G-062000-00), for the ventilator lid
- Gray liquid lacquer (P/N G-061361-00), for the ventilator cart
- White liquid lacquer (P/N G-061999-00), for the ventilator cabinet

8.1.9 Replacement part ordering

To order correct parts, identify the ventilator version and part, then use Section 9 to locate it. To replace a part that is not stocked or that is unavailable, order the next higher assembly. Retain the part to be replaced until the replacement part is obtained, and compare the two for compatibility, if possible.

8.1.10 Post-repair

After you complete any ventilator repair, do the following:

- Visually verify that all pneumatic and electrical parts are properly connected and that all parts are properly installed. Then, with a light tug, verify that connections are secure and that parts are securely attached. Listen for any uncharacteristic sounds (pneumatic leaking, vibrations, grinding, squeaking, or others). Be sure the piston, fans, pump, panel hinges, and casters move freely. Check for any unusual odors.
- Run indicated portions of the performance verification (see Table 5-1) before placing the ventilator on a patient.
- Keep a maintenance log of all repairs. Make sure service records and other documentation are completed.

8.2 Patient system and accessories

For maintenance of the patient system and accessories, consult the *700 Series Ventilator System Operator's Manual* or applicable accessory manuals.

Warning

Connectors and tubes with the proprietary Bennett barbed cuff fittings are intended for use only with like fittings. They are not interchangeable with ISO-standard cone and socket fittings. A leaktight connection cannot be ensured if these two fitting types are combined. Adapters may be used to connect Bennett barbed cuff fittings to ISO-standard cone and socket fittings.

8.3 Cart assembly

Warning

- To prevent equipment damage, pull, rather than push, the ventilator over high thresholds when using the cart to transport the ventilator. Ensure that the flex arm is positioned at the front of the ventilator.
- To prevent possible personal injury, never attempt to lift the ventilator without assistance. When lifting the ventilator, lift from the base, use assistance, and take appropriate safety precautions.

8.3.1 Removing/installing ventilator from/to cart

Remove the ventilator from the cart as follows. Install by reversing removal procedure.

1. Make sure brakes on cart are engaged.
2. Using 5-mm hex driver, remove two M6 x 16 screws, flat washers, and external lockwashers from side of cart (Figure 8-1).
3. With another person holding ventilator (to prevent it from toppling), push ventilator away from side of cart where screws were, until ventilator's L-shaped interlocking rails slide clear of slots in cart (approximately $^1/_8$ in.) (Figure 8-2).
4. Lift ventilator straight up off cart.

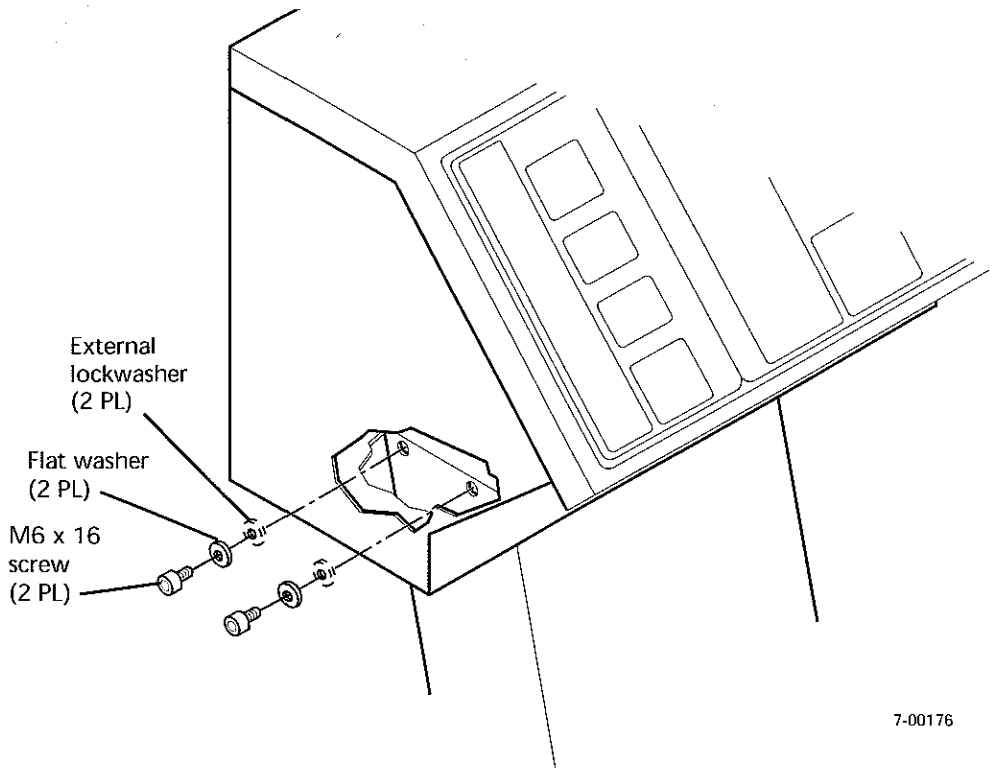

Figure 8-1. Removing ventilator attachment screws from cart

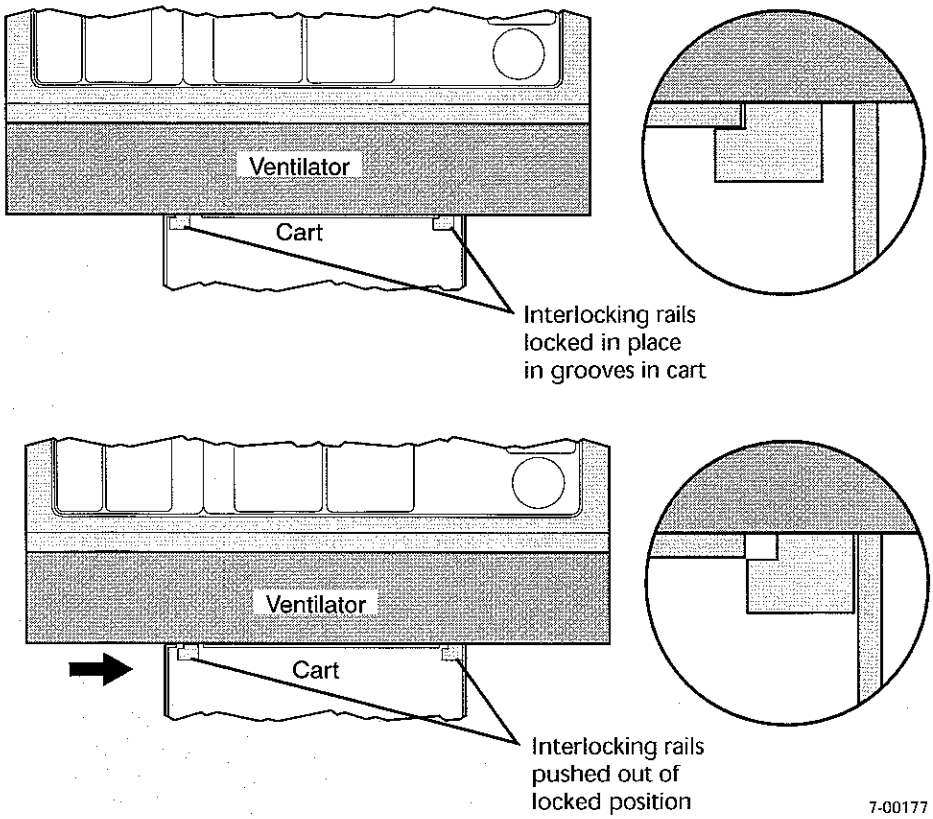

Figure 8-2. Removing ventilator from cart

8.3.2 Removing/installing oxygen cylinder brackets (Figure 8-3)

Remove the oxygen cylinder brackets from the cart as follows. Install by reversing removal procedure.

1. Loosen cylinder-retaining wing screws. Lift out cylinders.
2. Using 7-mm nutdriver, remove four M4 nuts with captive lockwashers that retain each of two lower cylinder supports. Remove supports.
3. Using 5-mm hex driver, remove two M6 x 16 screws, flat washers, and split-ring washers that retain each of two upper cylinder brackets. Remove brackets.

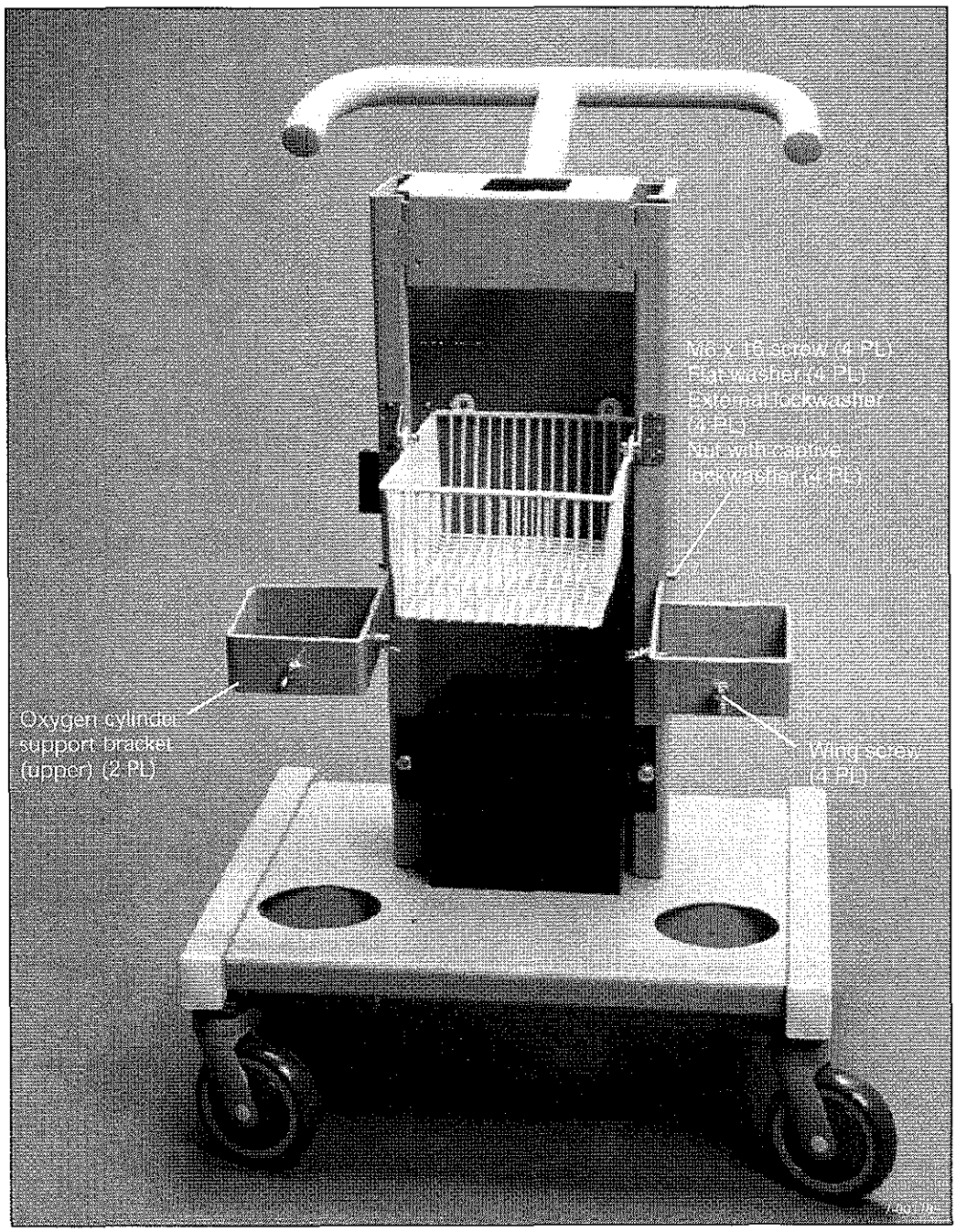
M6 x 16 screw (2 PL)
Flat washer (2 PL)
External lockwasher (2 PL)
Nut with captive lockwasher (4 PL)
Oxygen cylinder support bracket (upper) (2 PL)
Wing screw (4 PL)

Figure 8-3. Removing oxygen cylinder brackets

8.3.3 Removing/installing cylinder covers

Using 7-mm nutdriver, remove four nuts with captive lockwashers that retain each cylinder cover. Install by reversing removal procedure.

8.3.4 Removing/installing collector vial support bracket (Figure 8-4)

Using 3-mm hex driver, remove two M4 x 8 screws, flat washers, and split-ring washers that retain bracket to cart. Remove bracket. Install by reversing removal procedure.

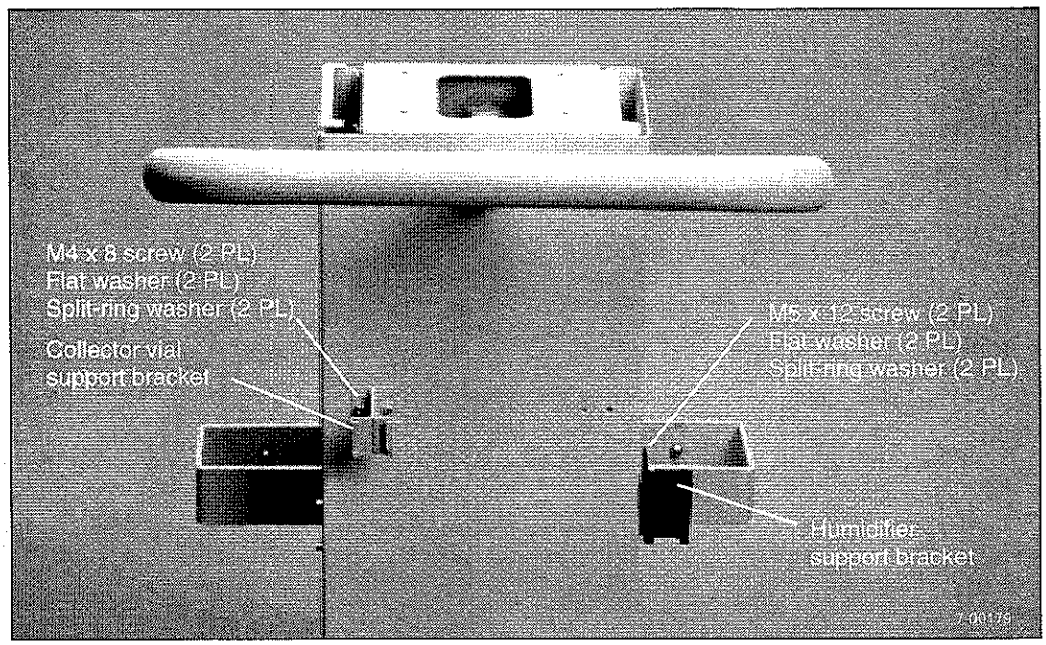
M4 x 8 screw (2 PL)
Flat washer (2 PL)
Split-ring washer (2 PL)
Collector vial support bracket
M6 x 12 screw (2 PL)
Flat washer (2 PL)
Split-ring washer (2 PL)
Humidifier support bracket

Figure 8-4. Removing collector vial and Fisher & Paykel Humidifier support brackets from cart

8.3.5 Removing/installing humidifier support bracket

8.3.5.1 Fisher & Paykel humidifier support bracket (Figure 8-4)

Using 4-mm hex driver, remove two M5 screws, flat washers, and split-ring washers that retain bracket to cart. Remove bracket. Install by reversing removal procedure.

8.3.5.2 Hudson RCI humidifier support bracket assembly (Figure 8-5)

Remove two M6 x 20 screws, split-ring washers, and flat washers that retain bracket assembly to cart. Remove bracket. Disassemble bracket assembly as required. Install by reversing removal procedure.

8.3.6 Removing/installing basket (Figure 8-6)

Partially remove screw retaining one of two basket-retaining ball brackets. Slip basket off studs on ball brackets and studs on inside of column. Install by reversing removal procedure.

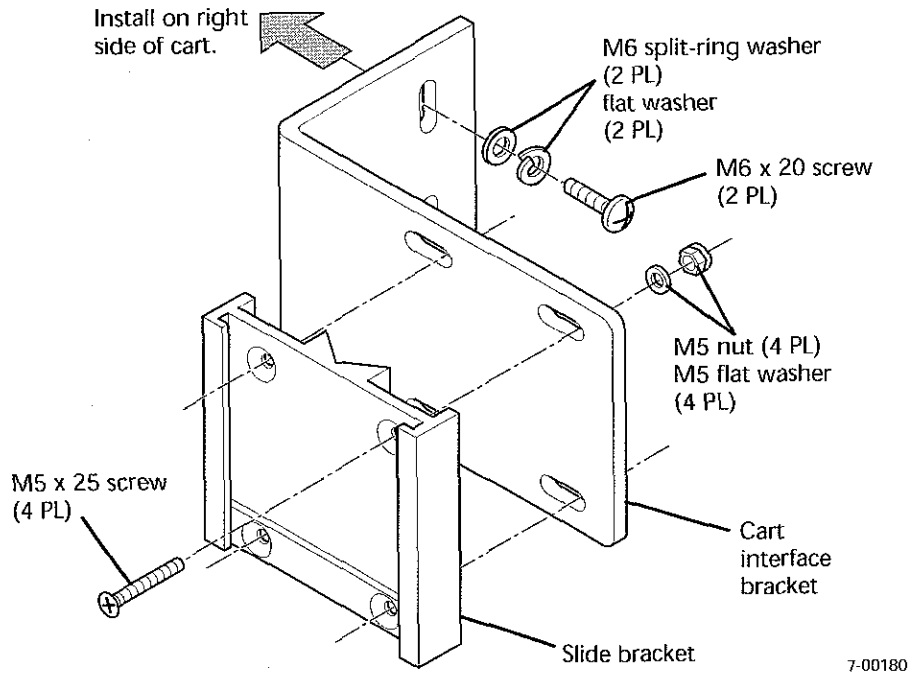
Install on right side of cart.
M6 split-ring washer (2 PL)
flat washer (2 PL)
M6 x 20 screw (2 PL)
M5 nut (4 PL)
M5 flat washer (4 PL)
M5 x 25 screw (4 PL)
Cart interface bracket
Slide bracket
7-00180

Figure 8-5. Removing Hudson RCI humidifier bracket assembly

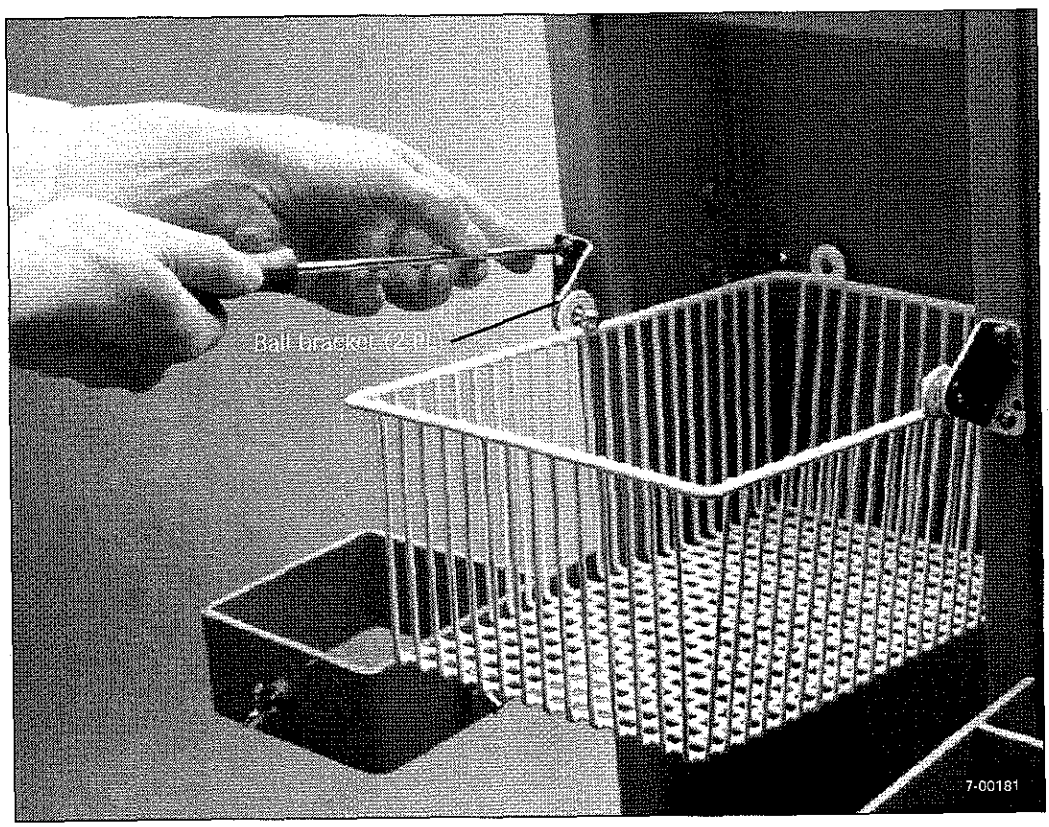

Figure 8-6. Removing basket

8.3.7 Removing/installing external battery and cover (Figure 8-7)

Remove the external battery and cover from the ventilator as follows. Install by reversing removal procedure.

1. Disconnect battery from external battery connector at rear of ventilator.
2. Loosen two captive thumbscrews that retain external battery cover. Remove cover.
3. Remove battery.

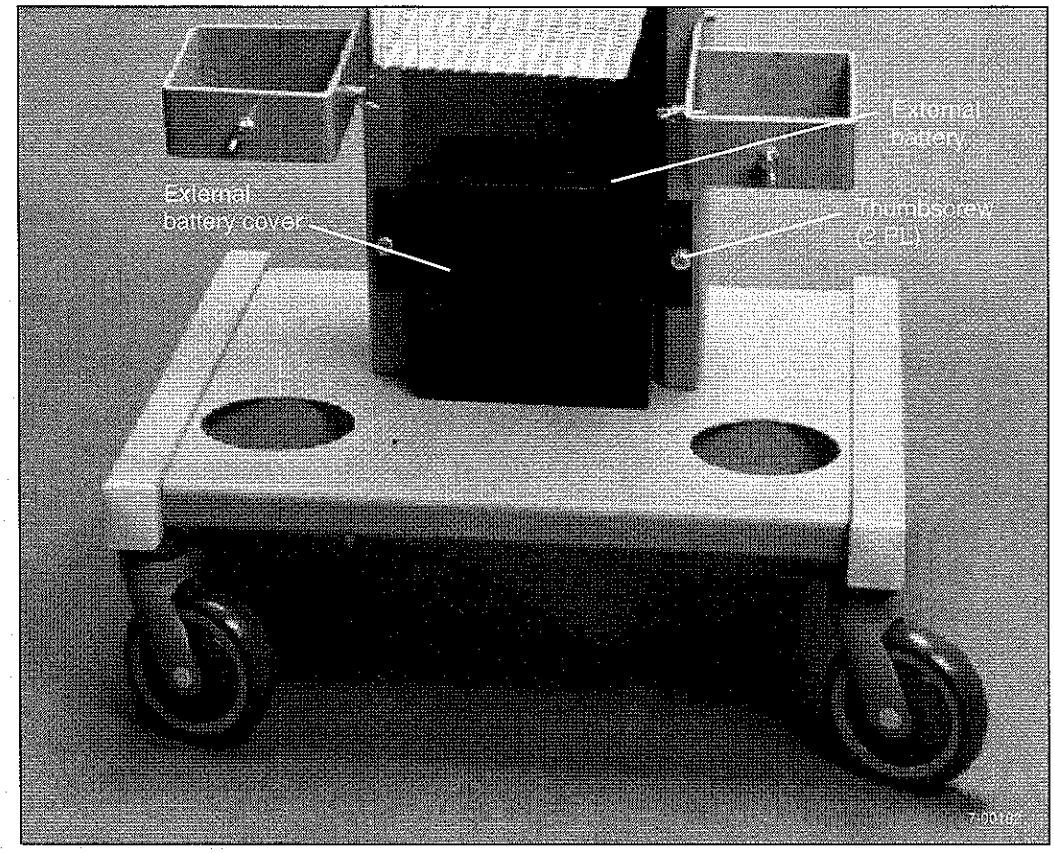

Figure 8-7. Removing external battery cover

8.4 Shelf mount

Warning

To prevent possible personal injury, never attempt to lift the ventilator without assistance. When lifting the ventilator, lift from the base, use assistance, and take appropriate safety precautions.

8.4.1 Removing/installing ventilator from/to shelf mount

Remove the ventilator from the shelf mount as follows. Install by reversing removal procedure.

1. Using 4-mm hex driver, remove M5 x 8 screw, flat washer, and split-ring washer that attach shelf mount to ventilator (Figure 8-8).
2. While facing ventilator, slide ventilator to your right until interlocking rails clear slots on shelf mount bracket (Figure 8-9).

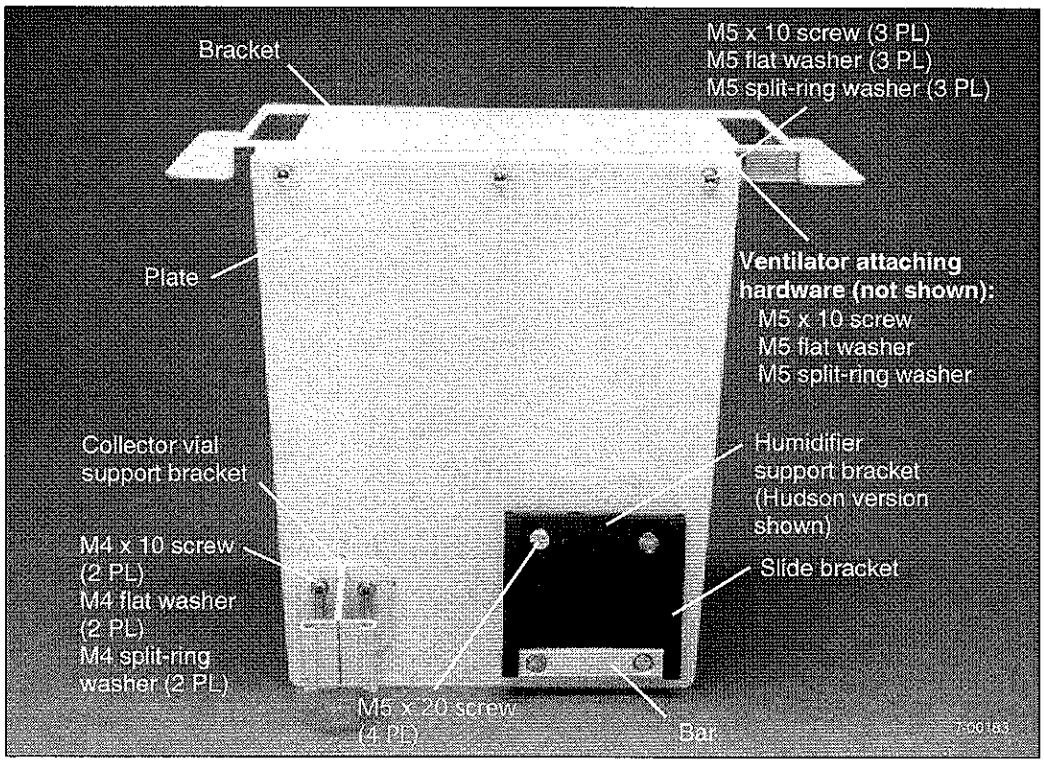

Figure 8-8. Removing collector vial and humidifier support brackets from shelf mount

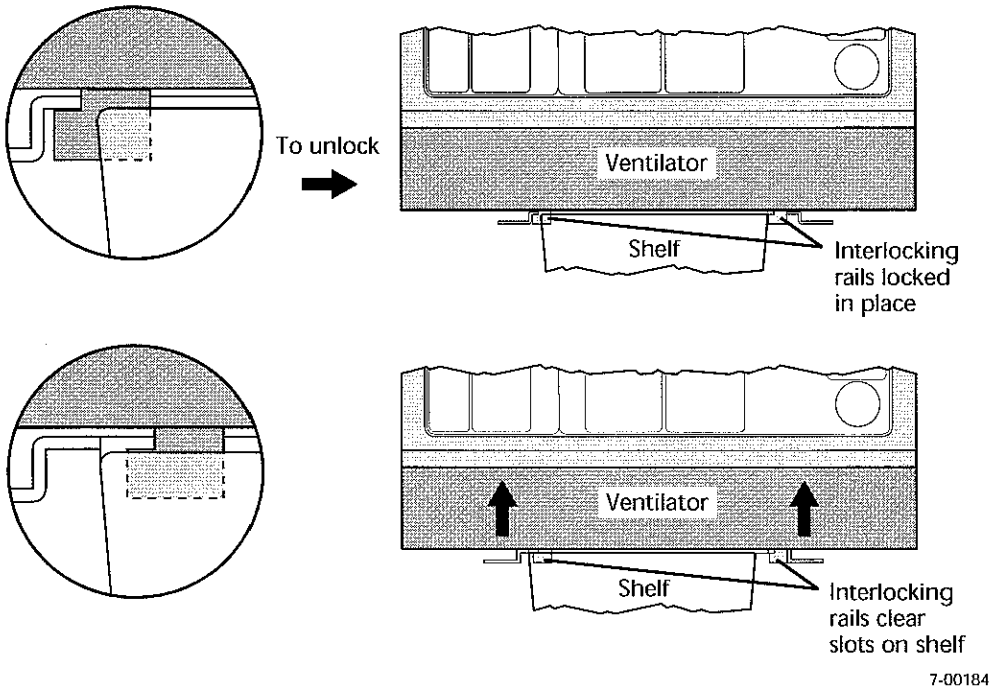

Figure 8-9. Removing shelf mount from ventilator

8.4.2 Removing/installing collector vial support bracket (Figure 8-8)

Using 3-mm hex driver, remove two M4 x 10 screws, flat washers, and split-ring washers that retain support bracket to shelf mount plate. Remove support bracket. Install by reversing removal procedure.

8.4.3 Removing/installing humidifier support bracket (Figure 8-8)

Remove two M5 x 10 flat-head screws (Fisher & Paykel bracket) or four M5 x 20 flat-head screws (Hudson RCI bracket) that retain support bracket to shelf mount plate. Remove bracket. Install by reversing removal procedure.

8.5 User interface (UI) assembly (lid)

8.5.1 Opening and propping lid

1. Using 3-mm hex driver, loosen M4 x 12 screws on latch-retaining brackets (Figure 8-10). Swing brackets aside, and open latches.
2. Lift lid, then prop it up by tightening thumbscrew near center of lid hinge (Figure 8-11).

8.5.2 Removing/installing lid

Remove the lid from the ventilator, as follows. Install by reversing removal procedure.

1. Open and prop lid (Section 8.5.1).
2. Disconnect UI/ventilator head cable from controller PCB (Figure 8-10).
3. Using 8-mm nutdriver, remove M5 nut, flat washer, and internal lockwasher that retain ground wire. Detach ground wire from lid.
4. Unprop lid by loosening thumbscrew.
5. Remove lid by pulling plunger on rear wall of cabinet assembly while sliding lid to right.

Caution

- To prevent damage to the lid, take care to prevent it from falling off during removal. Do not hold the lid assembly by grabbing on to the UI display PCB.
- To avoid damaging the keyboard, do not press on it with sharp objects and place it on clean work surface free of debris.

6. To service lid, place it upside-down on clean work surface free of debris. Support lid to prevent damage to knob/encoder.

Caution

To prevent damage to ESD-sensitive components, always follow ESD guidelines when servicing the lid.

NOTE:

When installing a new lid, transfer tension clips and attaching nuts from original to new lid.

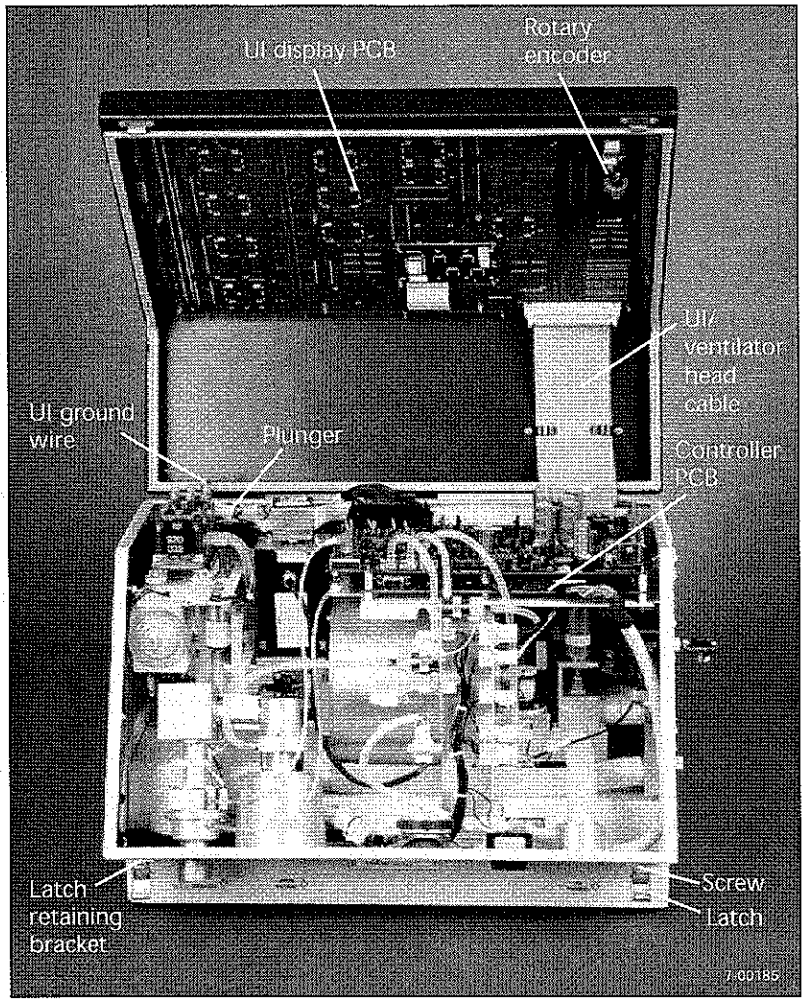

Figure 8-10. Lid raised

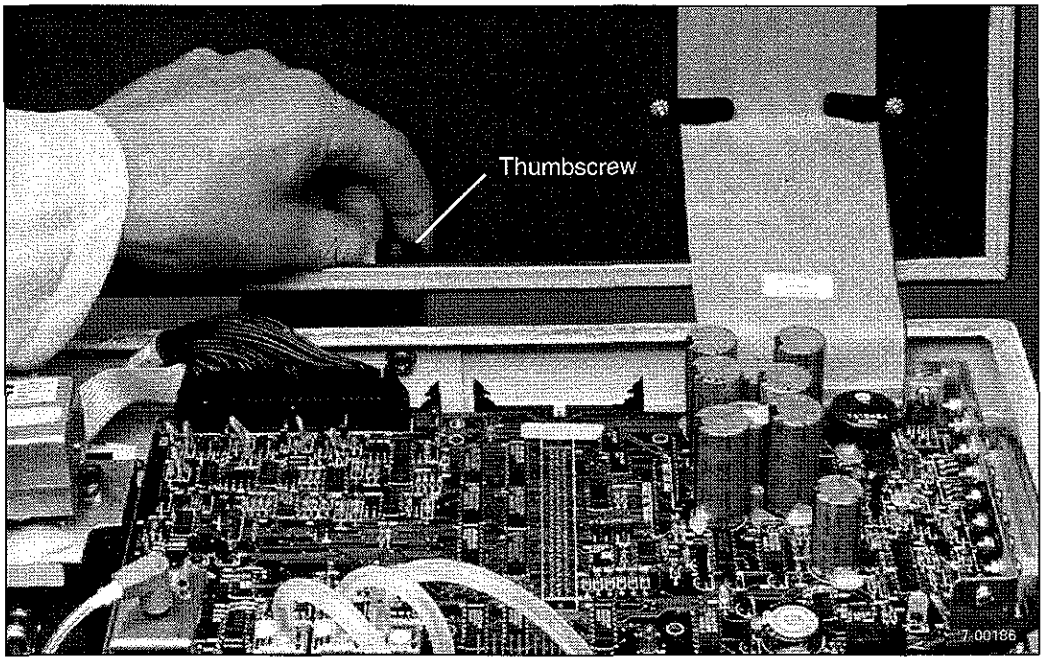

Figure 8-11. Propping the lid

8.5.3 Knob and rotary encoder (Figure 8-12)

Remove the knob and rotary encoder as follows. Install by reversing removal procedure.

1. Open and prop lid (Section 8.5.1).
2. Using 1/16-in. hex driver, loosen setscrew in knob. Remove knob.
3. Using 11-mm nutdriver or wrench, remove nut and internal lockwasher from switch shaft.
4. Disconnect rotary encoder cable from UI display PCB.
5. Pull out rotary encoder.

NOTE:

When removing the rotary encoder, be careful not to lose the nylon spacer installed beneath the UI.

8.5.4 UI display PCB (Figure 8-12)

Caution

When disassembling the UI, account for all fasteners removed, as fasteners falling between the keyboard and the UI display PCB may cause equipment failure.

Remove the UI display PCB as follows. Install by reversing removal procedure.

1. Remove lid (Section 8.5.2).
2. Disconnect rotary encoder cable.
3. Remove LCD panel (Section 8.5.5).
4. Disconnect UI and keyboard cables.
5. Using 7-mm nutdriver, remove 12 M4 nuts and external lockwashers. Lift out PCB.

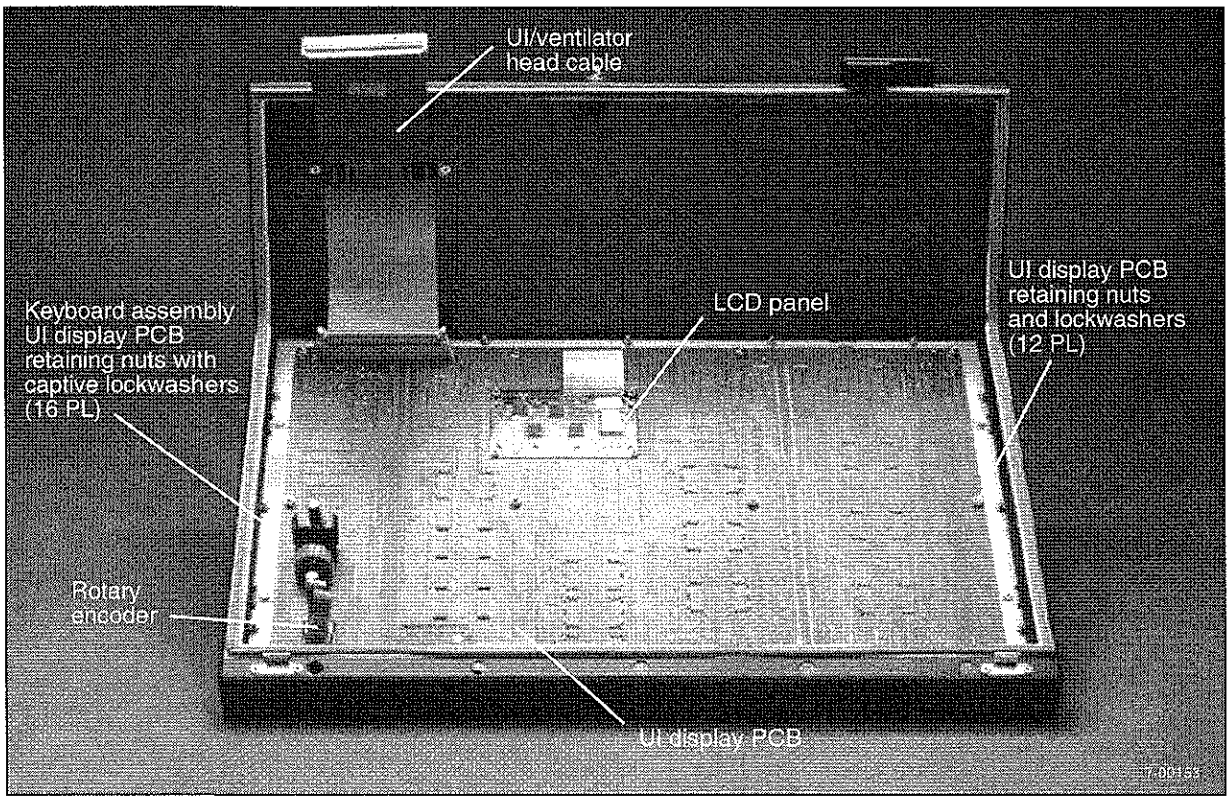
UI/ventilator head cable
Keyboard assembly UI display PCB retaining nuts with captive lockwashers (16 PL)
LCD panel
UI display PCB retaining nuts and lockwashers (12 PL)
Rotary encoder
UI display PCB

Figure 8-12. UI removed

8.5.5 LCD panel (message window)

Caution

When disassembling the UI, account for all fasteners removed, as fasteners falling between the keyboard and the UI display PCB may cause equipment failure.

Remove the LCD panel as follows. Install by reversing removal procedure.

1. Remove lid (Section 8.5.2).
2. Using 5-mm nutdriver, remove four M2.5 nuts, internal lockwashers, and fiber washers that attach LCD panel to UI display PCB. Remove LCD panel (Figure 8-13).
3. Detach LCD panel ribbon cable from UI display PCB (Figure 8-12).

NOTE:

When installing the LCD panel, be sure ribbon cable is at top of panel.

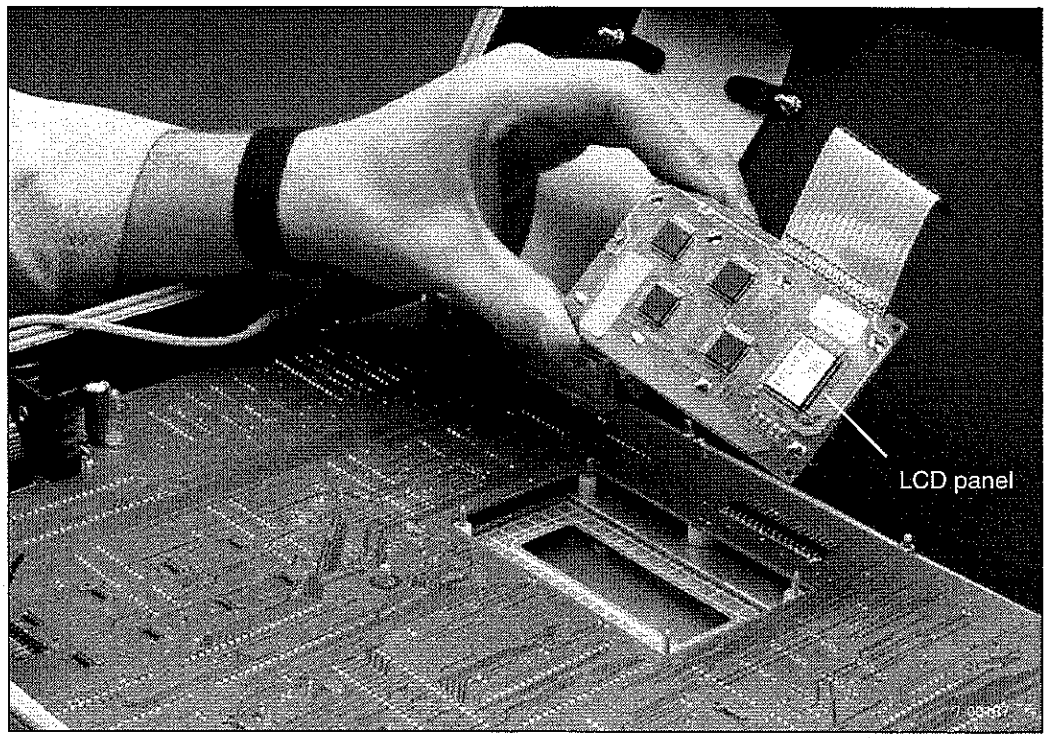

Figure 8-13. Removing LCD panel

8.5.6 Keyboard assembly

Caution

When disassembling the UI, account for all fasteners removed, as fasteners falling between the keyboard and the UI display PCB may cause equipment failure.

Remove the keyboard assembly as follows. Install by reversing removal procedure.

1. Remove LCD panel (Section 8.5.5).
2. Disconnect UI/ventilator head cable from UI display PCB.
3. Using 5.5-mm or $^{7}/_{32}$-in. nutdriver, remove 16 M3 nuts with captive external lockwashers that attach keyboard assembly/UI display PCB to lid (Figure 8-12). Lift out assembly.
4. Separate keyboard assembly from UI display PCB:
   a. Using 7-mm nutdriver, remove 12 M4 nuts and external lockwashers.
   b. Disconnect cables (keyboard and rotary encoder) from UI display PCB. Separate PCB from keyboard.
5. If you are installing a new keyboard assembly, unscrew and transfer 16 nylon spacers from original keyboard assembly to new keyboard assembly (Figure 8-14).

NOTE:

When installing the keyboard assembly to the lid, make sure the keyboard is oriented with the bar graph to your right. Do not overtighten the nuts. Inspect the UI panel windows for smudges or debris. Clean as required using UI cleaning spray (P/N G-061576-00).

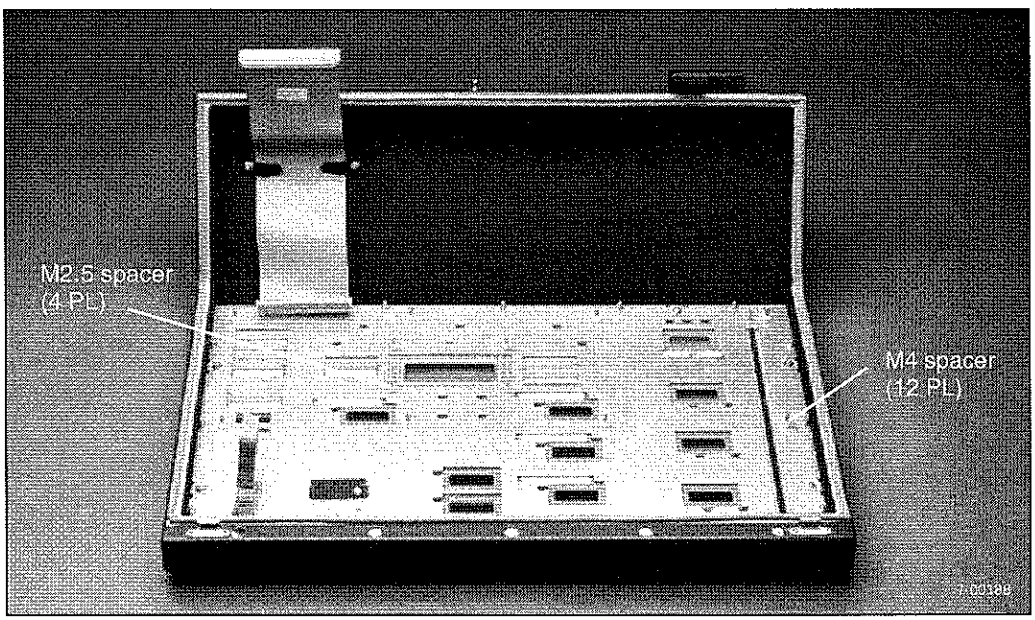

Figure 8-14. Spacers on keyboard assembly

8.6 Ventilator head cabinet assembly

8.6.1 Oxygen adapter assembly

To remove the oxygen adapter assembly (if ventilator is so equipped), unscrew it from the ventilator's standard male DISS fitting. The oxygen adapter assembly can also be disassembled (as required) while it is on or off the ventilator (Figure 8-15).

To install the oxygen adapter assembly, remove any existing PTFE tape from the ventilator's DISS male fitting and apply new tape (P/N G-060759-00). Screw adapter assembly onto DISS fitting. Leak-test by applying leak test fluid (P/N 4-004489-00) with a suitable small brush to all connections between where the hose attaches and the male DISS fitting inlet. If new bubbles form, repair the leak. Use a clean cloth to remove the leak detector.

NOTE:

- When assembling oxygen adapters, use PTFE tape as shown in Figure 8-15. On the Australian fitting, use PTFE tape on all threads of the male DISS fitting and on the threaded male adapter. PTFE tape is not required on the male DISS fitting if you are using a DISS female hose (USA) or a Dräger hose.
- To prevent tape debris from coming loose and entering the pneumatic system, do not wrap tape around the first two threads.

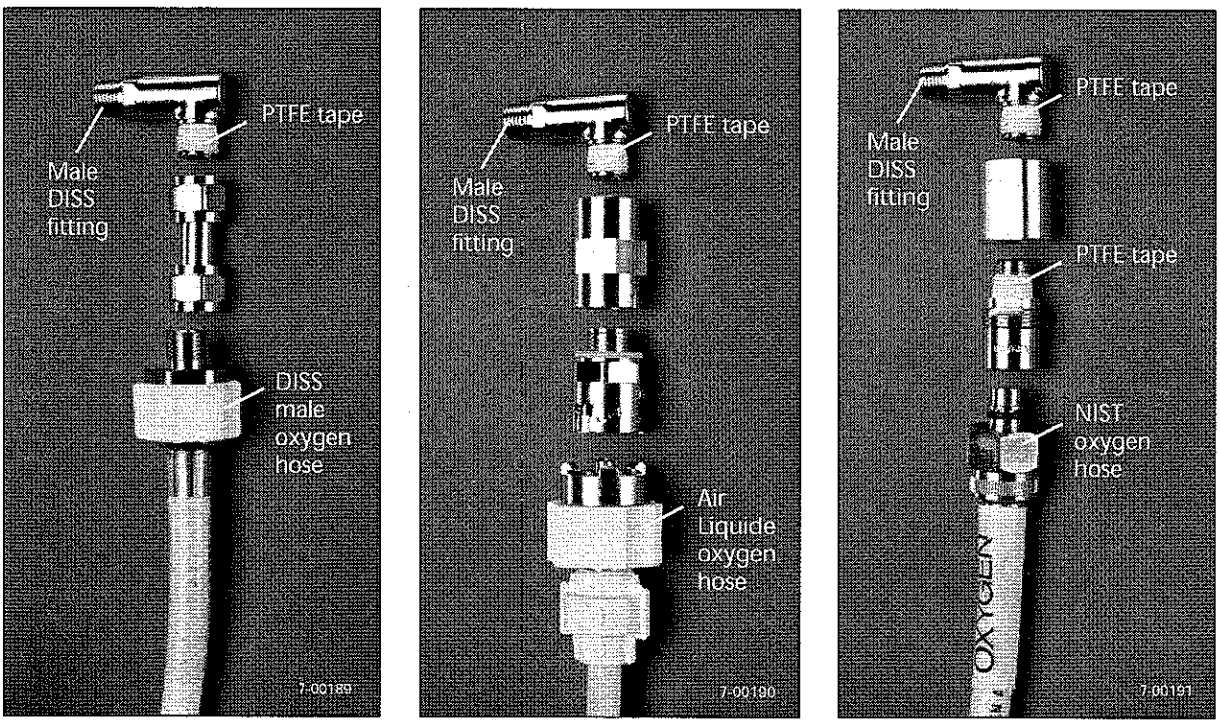

Figure 8-15. Oxygen adapter assemblies disassembled

8.6.2 Options panel plate (Figure 8-16)

Remove options panel plate by removing seven M3 x 8 POZIDRIV screws with captive washers. Install by reversing removal procedure.

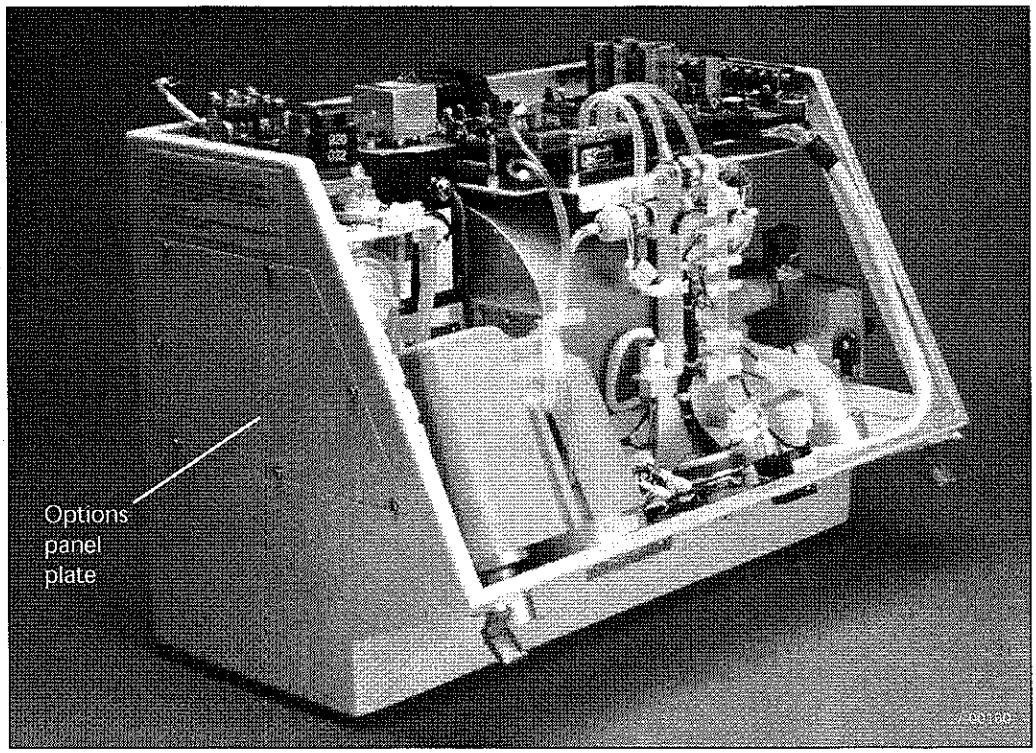

Figure 8-16. Options panel plate